Dynamic Chemical Process Modelling Using a Multiple Basis Function Genetic Programming Algorithm

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Abstract

In this contribution we outline how a Multiple Basis Function Genetic Programming (MBF-GP) algorithm can be used to evolve input-output models of dynamic chemical processes. Two case studies are used to compare the performance of the algorithm with that of a standard GP algorithm. It was found that the MBF-GP algorithm was able to develop dynamic process models of a significantly greater accuracy than the standard GP algorithm

1 INTRODUCTION

Previous work (McKay et al., 1997) has shown that Genetic Programming (GP) is able to evolve accurate input-output models of steady-state chemical process systems. However, it is often necessary for the engineer to be able to accurately predict the dynamic response of the process in question. Therefore, the aim of this work is to extend the use of the GP methodology to the modelling of dynamic chemical process systems.

2 DYNAMIC MODELLING USING GP

In this contribution, GP is used to develop discrete time process models where the model output is a function of past values of the input(s) and the output. The resulting models are similar to NARMAX (Non-linear Auto-Regressive Moving Average with eXogeneous inputs) type models described by Chen and Billings (1989).

2.1 ALGORITHM DETAILS

The MBF-GP algorithm is exactly the same as the standard GP algorithm (McKay et al., 1997) apart from the fact that each population member is a linear sum of a number of non-linear basis functions. The resulting model is linear in the parameters which means that the model constants can be optimised using the method of recursive least squares (RLS). This is not the case for the standard GP algorithm and therefore a Levenberg-Marquardt non-linear least squares optimisation routine is used.

2.2 CASE STUDIES

Two case were used to compare the performance of the MBF-GP algorithm with that of a standard GP algorithm. The first is a non-linear single-input single-output test system from the literature (Wang, 1994). The second involves modelling the degree of starch gelatinisation in an industrial cooking extruder.

3 CONCLUSIONS

The results of the two case studies show that, although there was not a great deal of difference between the accuracy of the best model obtained from each set of algorithm runs, the overall accuracy of the model predictions was much greater for the MBF-GP algorithm. Another advantage was that run times for the MBF-GP algorithm were significantly lower due to the use of the RLS optimisation routine.

References

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